# DEMO CIRCUIT 985
# QUICK START GUIDE

## LTC4245CUHF

# Multiple Supply Hot Swap Controller with I²C Compatible Monitoring

## DESCRIPTION

Demonstration circuit 985 showcases the LTC®4245 Hot Swap™ controller with I²C™ compatible monitoring in a CompactPCI™ (CPCI) application. The LTC4245 resides on the plug-in board, DC985A-A, which carries a female CPCI connector. This board plugs into the male connector on the backplane board, DC985A-B. The plug-in board also carries the four n-FET switches and sense resistors required for hot swap. LEDs provide visual indication of the important signals and voltages.

The board can be configured to work in a PCI Express™ application by adjusting a few jumpers. To access the powerful monitoring features of the LTC4245, the I²C port on the backplane board must be connected to a DC590 board (available separately). The LTC4245 can then be controlled with evaluation software running on a host PC.

**Design files for this circuit board are available. Call the LTC factory.**



## PERFORMANCE SUMMARY

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Input Supply Range | MOSFET Q1-Q4 On, TVS Z1-Z4 Off | | | | |
| | +12V IN | | 10.8 | 12 | 15 | V |
| | +5V IN | CFG Jumper, JP4, at LOW or FLOAT | 4.5 | 5 | 6 | V |
| | | CFG Jumper, JP4, at HIGH | 2.9 | 3.3 | 6 | V |
| | +3.3V IN | | 2.9 | 3.3 | 6 | V |
| | -12V IN | CFG Jumper, JP4, at LOW | -10.8 | -12 | -15 | V |
| | | CFG Jumper, JP4, at FLOAT or HIGH | 0 | | -15 | V |
| $I_{OUT,CB}$ | Circuit Breaker Trip Current | After Start-Up | | | | |
| | +12V OUT | R1 = 8mΩ, 1% | 5.5 | 6.25 | 6.9 | A |
| | +5V OUT | R2 = 3.5mΩ, 1% | 6.4 | 7.1 | 7.9 | A |
| | +3.3V OUT | R3 = 2.5mΩ, 1% | 8.9 | 10 | 11.1 | A |
| | -12V OUT | R4 = 40mΩ, 1% | 0.99 | 1.25 | 1.52 | A |

## QUICK START PROCEDURE

1. Verify that the jumpers are set as follows:

   Backplane board: **JP1** BD_SEL#: LOW; **JP2** PCI_RST#: HIGH

   Plug-in board: **JP3** ON CONFIG: AUTO; **JP5** PGI: HIGH; **JP4** CFG: LOW if using all four supplies, FLOAT if using 12V, 5V and 3.3V, HIGH if using 12V, and two 3.3V.

2. Mate the plug-in board with the backplane board.

3. With the power off, connect the inputs supplies and output loads as shown in Figure 1. If –12V supply is not being used, ground –12V IN and –12V OUT turrets.

4. Turn on power at the inputs. Check that the LTC4245 automatically turns on. LEDs D1 to D4 indicate when input power is applied, and D5 to D8 show when it is available at the output. If the output voltages are within tolerance, HEALTHY# green LED, D9, turns on, and LOCAL_PCI_RST# red LED, D10, stays off. If the outputs remain off, check the fault registers (Step 8).

5. To access the ADC data or to control the LTC4245 through I$^2$C, install the QuickEval™ System software on a computer with an available USB port. The download website is http://www.linear.com/software. Open the QuickEval software. If already installed, update the software to obtain the LTC4245 driver.

6. Connect DC590 to the PC with a USB cable as shown in Figure 2. Connect the backplane board I$^2$C port, P2, to the DC590 USB controller board using the supplied 14-conductor ribbon cable. Upon connection, QuickEval will identify the DC985, and open the LTC4245 interface software window as shown in Figure 3.

7. In the software, choose the CFG Pin option that matches the CFG jumper, JP4, setting on the board. Click the Auto Find button in the I2C Address section, so the software can figure out the I$^2$C slave address of the LTC4245. After that, click the START button to get a continuous update of the LTC4245 internal registers. The software window displays the MOSFET and overall status.

8. Click Show Registers button for an expanded view of all the registers (Figure 4). The check-boxes can be used to selectively set or reset the corresponding register bit.

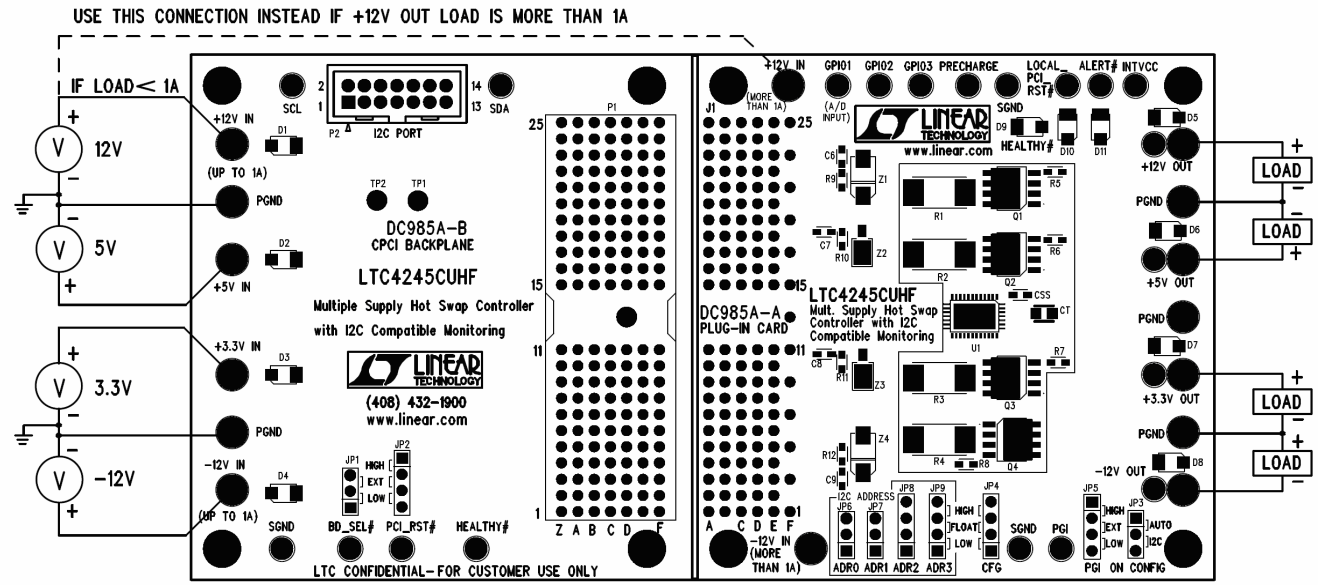



**Figure 1. Proper Measurement Equipment Setup**

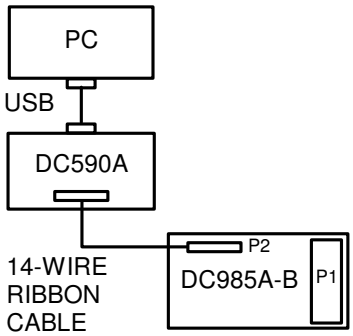



**Figure 2. QuickEval Setup**

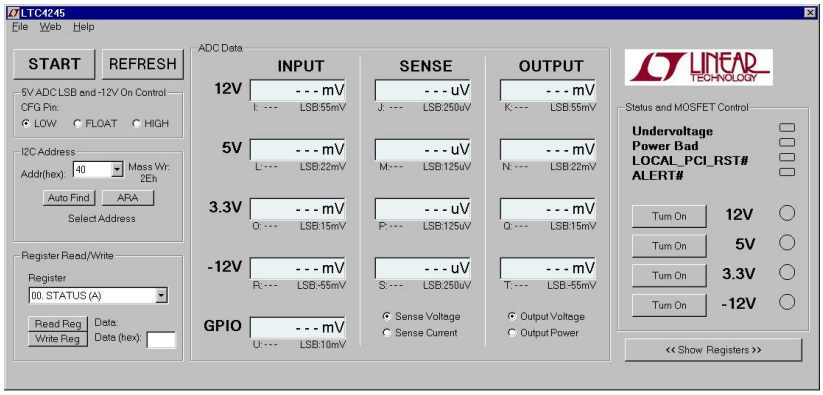



**Figure 3. Default LTC4245 QuickEval Interface**

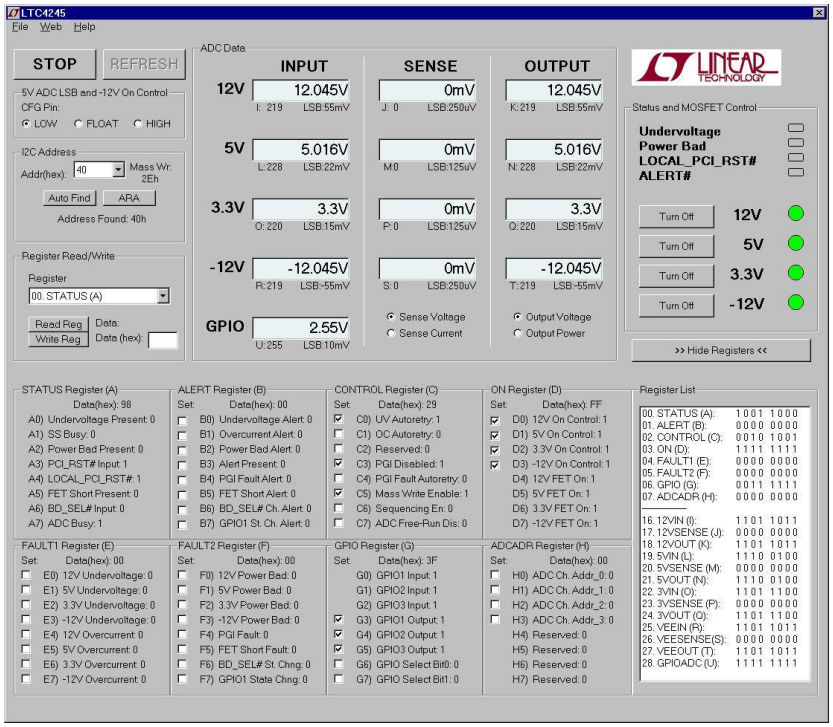



**Figure 4. LTC4245 QuickEval Interface with Register Display**

## HARDWARE SETUP

### BOARD LAYOUT

The top of the plug-in board contains the core Hot Swap controller and associated components, along with LEDs. Also on top are various configuration jumpers and all connection turrets. The large turrets may be removed to permit installation of up to 12 gauge wire for direct, low resistance connections to the board. None of the turrets are swaged.

The bottom of the boards contains components for software identification of the board, LED current limiting resistors, the CPCI connector (J1), and a spare sense resistor. Also on the bottom is the LTC4245 $INTV_{CC}$ bypass capacitor, C11, and the supply input and output capacitors. Except for C11, the other components are largely unrelated to the core application and are included for the purposes of the demo board itself. The spare 50mΩ sense resistor, R1OPT, can be used to replace the 8mΩ resistor (R1) on the 12V supply to lower its current limit to CPCI levels.

The boards are designed with two ground planes, on layers 2 and 3. Layer 2 is a small signal ground plane which picks up ground for LTC4245, the small SGND turrets, C11, CSS, CT, as well as $I^2C$ and configuration jumper related grounding. Layer 3 is reserved for large signal grounding, including capacitors on supply inputs and outputs, large PGND turrets, input and output LEDs, and input clamps and snubbers. These two ground planes join at the CPCI connector ground pins.

### HIGHER CURRENT ON ±12V

The CPCI connector pin DC current should be limited to 1A per pin. The 12V supply has 1 pin; 5V has 2 long and 6 medium pins; 3.3V has 2 long and 8 medium pins; –12V has 1 medium pin. The Si7880DP n-FET used on all four supplies is rated to 18A at room temperature.

The circuit breakers for the four supplies are set as shown in the Performance Summary table. It is dictated by the tolerance on the circuit breaker trip sense voltage and the sense resistor.

If the load current on the 12V supply is more than 1A, the +12V IN turret on the plug-in card should be used to supply the input current. Otherwise the 12V connector pin may be damaged. To use higher load currents on –12V OUT use the –12V IN turret on the plug-in card for the input power supply. The sense resistor R4 will also need to be replaced with a value lower than the installed 40mΩ.

### PCI EXPRESS APPLICATION

For PCI Express current levels, use the +12V IN turret on the plug-in card to supply input power. Set the CFG pin jumper (JP4) HIGH so a 3.3V supply can be used at the +5V IN turret. Ground the –12V IN and –12V OUT turrets. If needed, modify the sense resistors (R1 to R3) to adjust the circuit breaker levels.

### GPIO1 (A/D INPUT)

The GPIO1 turret is pulled up to 3.3V with a 100kΩ resistor. It can be used to measure voltages in a 0V to 2.56V

range. The result is displayed in the ADC Data section of the LTC4245 software window on the computer.

**PRECHARGE**

As soon as the LTC4245 $3V_{IN}$ pin is powered up, the PRECHARGE turret can source up to 70mA at 1V. This is used in CPCI to pre-bias the bus I/O lines during insertion. The turret facilitates hooking up the PRECHARGE pin to external circuitry.

**INTVCC**

INTVCC was included on the LTC4245 to allow bypassing of the internal 5.5V supply rail for superior noise immunity. It is also permissible to steal a small current of up to 3mA off the INTVCC pin to bias address pins or ancillary circuits. A turret is provided for connections to INTVCC.

**CONNECTORS**

**J1:** Plug-in card female CompactPCI connector. This connector mates with the P1 connector on the backplane board to allow power and control signals to flow to the LTC4245 and the supply outputs. The connector utilizes guiding features to ensure correct polarized mating.

**P1:** Backplane card male CompactPCI connector. There are three lengths of pins on this connector. Long 5V, 3.3V and GND pins provide early power to the LTC4245. Majority of the pins are medium length. The short BD_SEL# pin mates last, and provides the turn-on signal to the LTC4245.

**P2** $I^2C$ PORT: Connector for DC590 $I^2C$ adapter card. This card converts a computer's USB port to $I^2C$. If P2 is not connected, the turret terminals SDA and SCL can be connected directly to an $I^2C$ bus.

**JUMPERS**

**JP1** BD_SEL#: Connects BD_SEL# backplane signal either to ground or leaves it floating, whereby it will be pulled up by the 1.2kΩ on the plug-in card to 5V. In the latter case, the BD_SEL# turret can be connected to external insertion-detect logic to initiate turn-on of LTC4245. Removing and reinstalling the shunt at LOW will cycle power to the board and also reset the LTC4245 fault registers.

**JP2** PCI_RST#: Sets the backplane reset signal PCI_RST# high, low or floating. When floating, the PCI_RST# turret should be driven with an external signal. This jumper will affect the LOCAL_PCI_RST# output of the LTC4245 (LED D10).

**JP3** ON CONFIG: At start-up the LTC4245 operates in one of two modes: in AUTO mode it turns on when BD_SEL# goes low; in I2C mode it waits for an $I^2C$ turn-on command, even after BD_SEL# goes low, to turn-on the switches.

**JP4** CFG: Sets the CFG pin high, low or floating. This affects the input supply range requirement for FET turn-on. For a CPCI application requiring all four supplies, set it low. Refer the Performance Summary table and the datasheet for more details.

**JP5** PGI: Sets the PGI pin of the LTC4245 high, low or floating. When floating, the PGI turret should be driven with an external signal, such as the RESET# output of an external supply monitor. Setting the PGI pin

low can lead to a PGI fault causing all FETs to be turned off.

**JP6 to JP9** ADR0 to ADR3: Selects 1 of 32 possible addresses for the LTC4245 $I^2C$ interface by strapping the address pins high, low or allowing them to float. An address table is shown in the datasheet and the Help menu of the evaluation software. The software can automatically scan and identify the $I^2C$ address, regardless of the pin setting.

**LEDs**

**D1 to D8**: D1 to D4 indicate if the input supplies are high. D5 to D8 light up when the supply outputs power up, after the FET switches turn on.

**D9** HEALTHY#: This should light up at the end of the start-up timing cycle after all the supply outputs power up. It will turn off as soon as any FET switch is turned off or if any output falls out of tolerance.

**D10** LOCAL_PCI_RST#: This LED normally flashes briefly during start-up and power-down. This is because it is powered off +3.3V OUT and the pin is released at the end of the start-up timing cycle. It will be lit continuously if +3.3V OUT is high and PCI_RST# is set low with JP2.

**D11** ALERT#: The ALERT# pin pulls low and turns on this LED if a fault occurs and that fault's alert is enabled in the ALERT register. The alert can be cleared either by resetting bit B3 in the ALERT register or writing to the LTC4245 alert response address (ARA).

## SOFTWARE SETUP

Communicating with the LTC4245 $I^2C$ interface requires the QuickEval System software and a DC590 board. The QuickEval software is available from the website www.linear.com/software. The QuickEval software talks to the DC590 board through the USB port of the PC. The DC590 is connected to the $I^2C$ port (P2) on the DC985A-B with the supplied 14-wire ribbon cable (Figure 2). When connected, the QuickEval software identifies the DC985 and brings up the LTC4245 interface as shown in Figure 3. When experiencing problems with the software, try unplugging and plugging the DC590 board from the PC. Also refer the DC590 Quick Start guide.

**$I^2C$ ADDRESS SELECTION**

Select in the drop down list box the Write address byte of the LTC4245 that is to be communicated with. The address pins to $I^2C$ address map can be found in the Help menu. Easier still, the Auto Find button will scan through the 32 individual LTC4245 addresses and list which addresses responded with an acknowledge. If multiple LTC4245s are on the bus lines, the Mass Write address 2Eh can be selected to write to all LTC4245s at the same time. The ARA button sends the Alert Response protocol address and displays the address of the device holding its ALERT# pin low.

**5V ADC LSB AND –12V ON CONTROL**

Select the radio button that corresponds with the CFG pin jumper, JP4,

setting on the plug-in board. Refer to Table 1 for the effect of this setting on software parameters.

| CFG PIN | 5VIN LSB | 5VOUT LSB | -12V ON/OFF CONTROL BIT |
|---|---|---|---|
| LOW | 22mV | 22mV | D3 |
| FLOAT | 22mV | 22mV | D0 |
| HIGH | 15mV | 15mV | D0 |

**Table 1: CFG Pin Setting**

### START AND REFRESH BUTTONS

Click on the START button to enable a timer that continuously updates the interface with the latest data from the LTC4245. This button will display STOP when the timer is enabled. Click on STOP to stop the timer. Click on REFRESH for a single update.

### ADC DATA DISPLAY

The data read from the LTC4245 ADC registers I to U is displayed in an easy to read format by multiplying the data with the LSB size and displaying it as a voltage. The current sense values can be displayed as either a voltage drop (default) or a current. The sense resistance values cannot be edited while the software is in polling mode. There is also an option for displaying output power instead of output voltage.

### REGISTER DISPLAY OPTIONS

The bits of registers A to H are shown in detail by clicking on the Show Registers button (Figure 4). Checking a box to the left of each bit of the Read/Write registers sets the respective bit, while unchecking a box clears the bit. The bit status is shown to the right of each bit after every refresh of the interface. In the Register List box a bit map of all the registers is shown and is updated with each refresh of the interface.

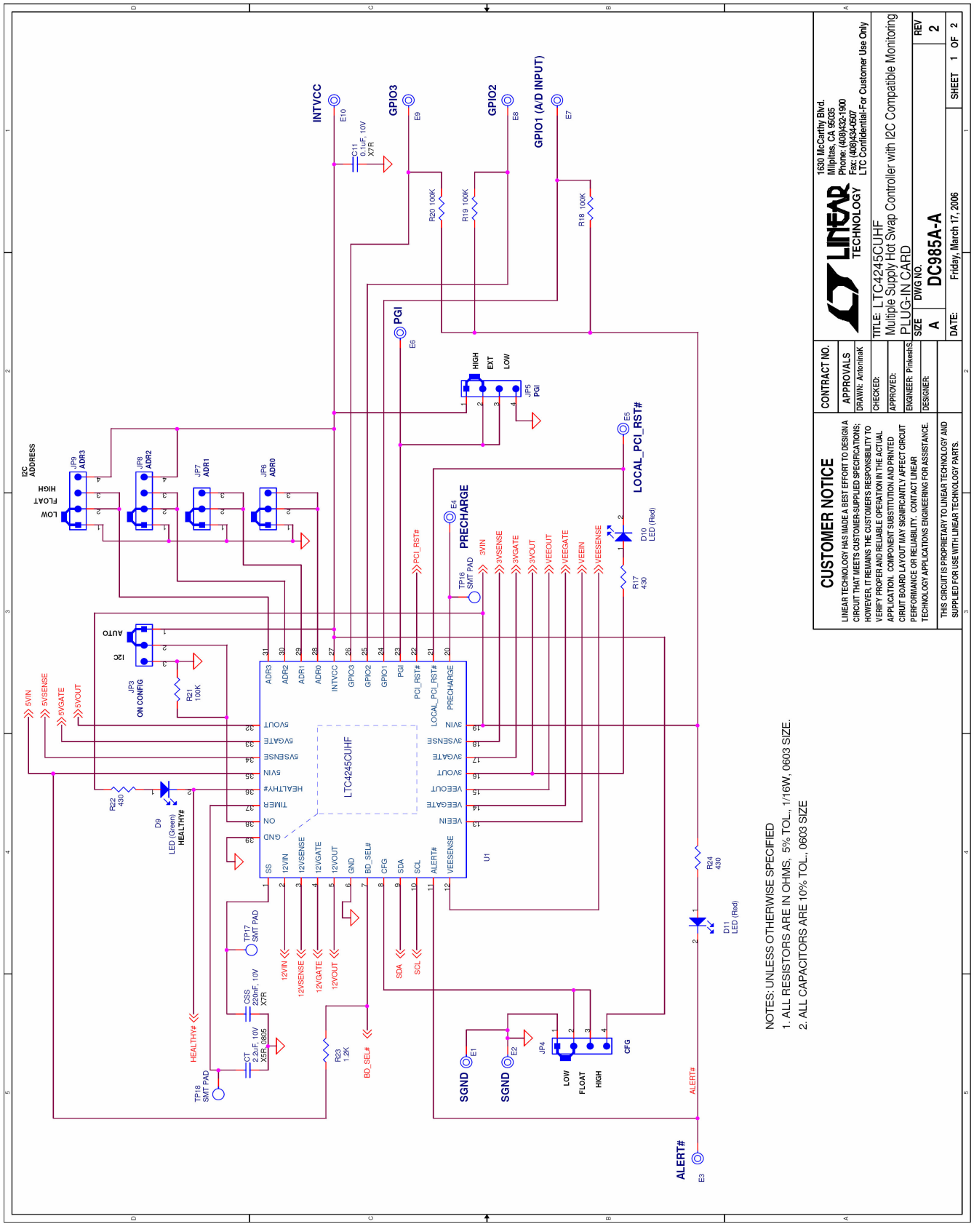
The Register Read/Write section allows for the user to enter and write data to a particular register. Select the register to be written to in the drop down menu. Enter the data in hex and click on Write to send the data, and then click Read to verify the write. Read data is displayed both in hex and decimal.

### MOSFET STATUS AND CONTROL

The MOSFET status is shown with a display, which is colored:

- Green, when the FET On Status bit (D4 to D7) is high; the FET control button will read "Turn Off"
- Clear, if FET On Status bit is low and the corresponding FET On control bit (D0 to D3) is also low; the FET button will read "Turn On"
- Red, if FET On Status bit is low and the corresponding FET On control bit is also high; the FET control button will read "Clear Fault"

The "Turn On" control button sets the corresponding supply's FET On control bit high, while "Turn Off" clears it to logic low. As mentioned before, if CFG pin radio button is set to FLOAT or HIGH, the -12V MOSFET is controlled with the 12V FET On control bit, D0, instead of D3. "Clear Fault" button writes zeros to the FAULT1 and FAULT2 registers, in an attempt to turn-on the MOSFETs by clearing fault bits. If a fault is still present, then that fault bit will be set again by the LTC4245, thus preventing turn-on.


INTVCC
GPIO3
GPIO2
GPIO1 (A/D INPUT)
PGI
PRECHARGE
LOCAL_PCI_RST#
ALERT#
SGND
LTC4245CUHF
U1
I2C ADDRESS
FLOAT
HIGH
LOW
ON CONFIG
AUTO
I2C
EXT
HEALTHY#
LED (Green)
LED (Red)
SMT PAD
CUSTOMER NOTICE
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DRAWN: AntoninaK
CHECKED:
APPROVED:
ENGINEER: PinkeshS.
DESIGNER:
LINEAR TECHNOLOGY
1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900
Fax: (408)434-0507
LTC Confidential-For Customer Use Only
TITLE: LTC4245CUHF
Multiple Supply Hot Swap Controller with I2C Compatible Monitoring
PLUG-IN CARD
SIZE
A
DWG NO.
DC985A-A
REV
2
DATE:
Friday, March 17, 2006
SHEET 1 OF 2
NOTES: UNLESS OTHERWISE SPECIFIED
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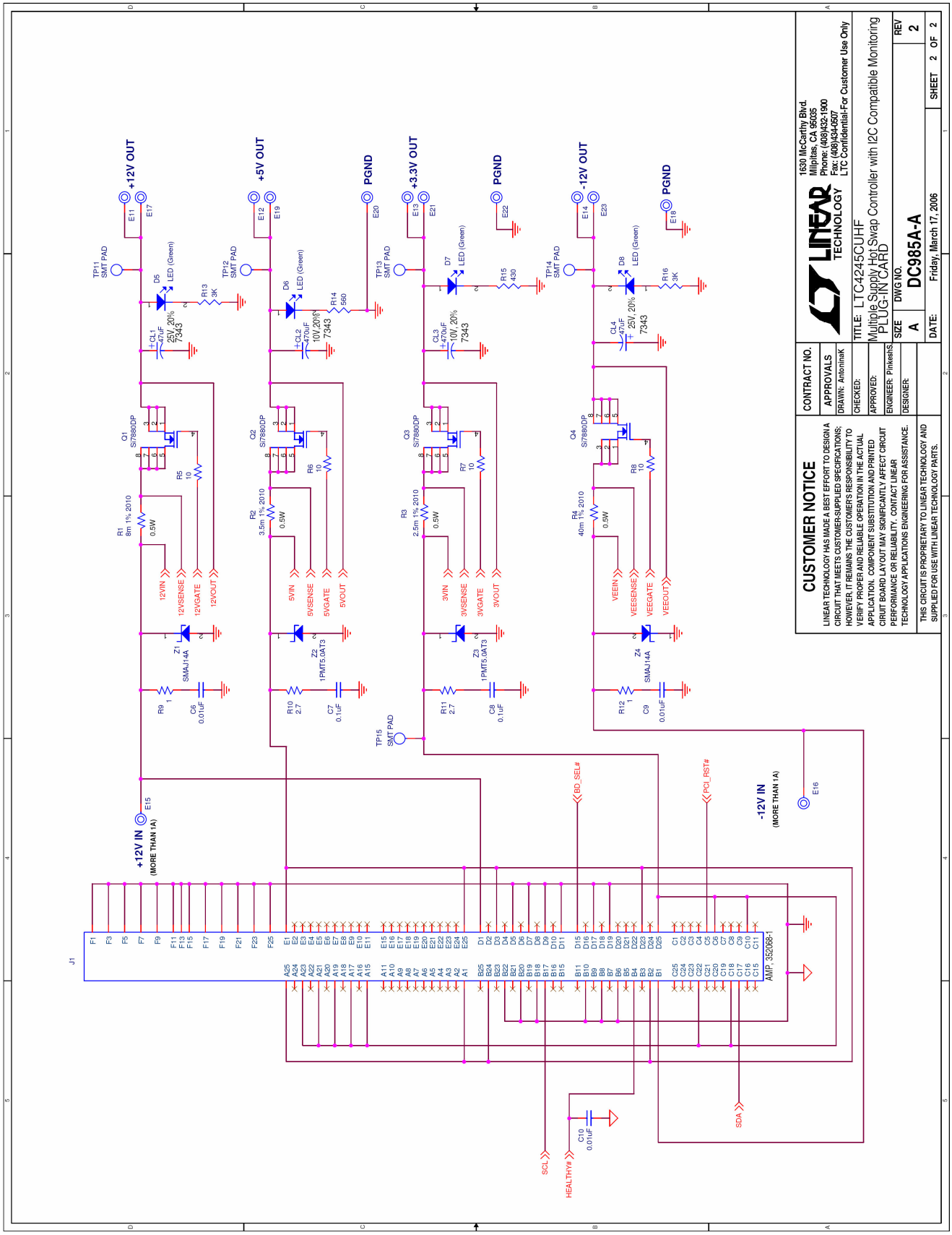
2. ALL CAPACITORS ARE 10% TOL., 0603 SIZE


+12V OUT
+5V OUT
PGND
+3.3V OUT
PGND
-12V OUT
PGND
+12V IN (MORE THAN 1A)
-12V IN (MORE THAN 1A)
BD_SEL#
PCI_RST#
SCL
SDA
HEALTHY#
AMP: 352088-1
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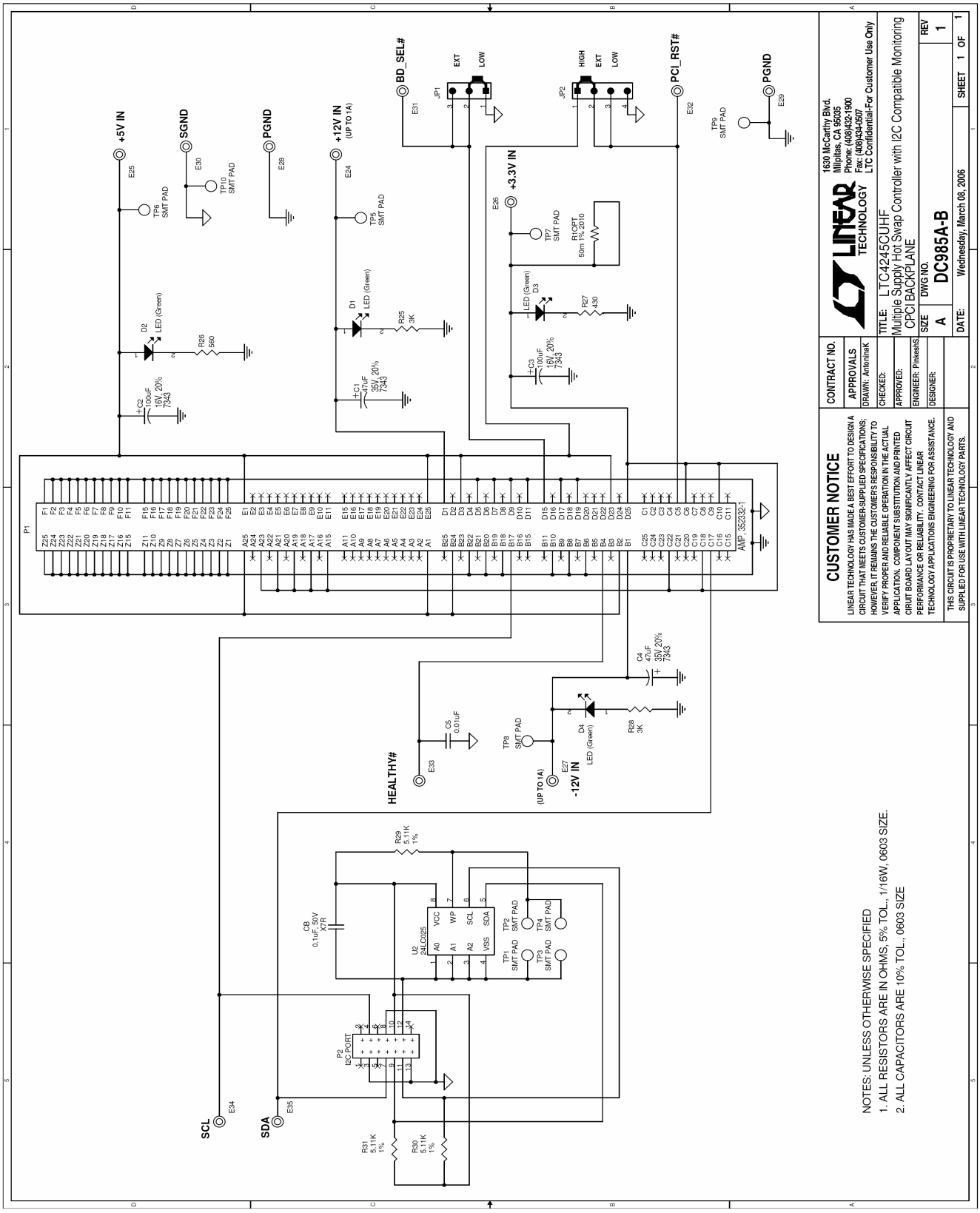
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SGND
PGND
+12V IN (UP TO 1A)
BD_SEL#
PCI_RST#
PGND
+3.3V IN
HEALTHY#
-12V IN (UP TO 1A)
SCL
SDA
P1
P2 I2C PORT
U2 24LC025
JP1
JP2
EXT
LOW
HIGH
LED (Green)
AMP, 352332-1
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REV 1
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SHEET 1 OF 1
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